LEXICAL FEATURES IN ADULTS WHO STUTTER

A Thesis in partial fulfilment of the requirements for the Degree of Master of Science at the University of Canterbury

by

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The material presented in this thesis is the original work of the candidate except as acknowledged in the text, and has not been previously submitted, either in part or in whole, for a degree at this or any other University.

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Abstract

The purpose of this study was to explore stuttering behaviour associated with word-type and word-frequency in a large group of adults who stutter (AWS). The study method involved analysing spontaneous speech samples of 50 AWS on the following features: 1) the occurrence of stuttering on content and function words, 2) the occurrence of stuttering on function words at the function/content word boundary, 3) the occurrence of syllable repetitions in relation to moments of stuttering on function and content words, and 4) word frequency of stuttered words compared to control words. Results indicated that moments of stuttering occurred more often on content words compared to function words. Furthermore, if stuttering occurred on a function word, it was found to occur most often at the function/content word boundary. No difference was found when the data were further analyzed as a function of frequency of stuttering. The AWS who had a high frequency of stuttering did not differ significantly from those with a low frequency of stuttering. Syllable repetitions occurred more often on function words compared to content words. In general, the AWS who showed a low frequency of stuttering exhibited a higher percentage of syllable repetitions. The word frequency of stuttered versus control words did not differ significantly. There was also no difference in word frequency for stuttered function versus stuttered content words. The results were interpreted to provide general support for the EXPLAN theory of stuttering behaviour proposed by Howell (2004) and colleagues (Howell & Au Yeung, 2002; Howell, Au-Yeung & Sackin, 2000).

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Introduction

Van Riper (1971) defined a moment of stuttering as, "*A word that is improperly patterned in time and the speaker's reaction thereto*" (p. 15). This seems a rather broad description of a stuttering moment; yet it remains an accurate, encompassing description due to the variety of symptoms and behaviours of people who stutter (PWS) (Bloodstein & Ratner, 2008). There are a proliferation of theories related to the moment and cause of stuttering. These theories vary in orientation, including physical descriptions, psychoanalytical interpretations, and language influences. For purposes of the present thesis, theories which consider the linguistic influences upon stuttering behaviour will be reviewed.

Language and Stuttering

There are a collection of theories and studies that attribute stuttering to a difficulty with some aspect of language. Not all authors agree on the specific language features that are problematic for PWS. Possibly the first research considering the linguistic influences upon stuttering was reported by Brown (1945). Brown examined factors influencing the loci of stuttering and identified four features that appeared to most influence moments of stuttering. The features that contributed to a moment of stuttering included, (1) words that were a noun, adjective, verb or adverb; (2) if the word was one of the first three in a sentence; (3) words that began with some consonant other than [th], [h], [w] and [t]; and (4) if the word contained five or more letters. On the basis of these features, various words could be 'weighted' in regard to their likelihood of being stuttered. Words which contained all four of these features were most heavily weighted.

Trotter (1956) expanded on the work of Brown (1945) by examining stuttering severity and word weight in PWS. He hypothesized that if words with higher weights are stuttered upon most frequently, the type of stuttering exhibited on these words would also be

rated as most severe by a listener. His results confirmed that moments of stuttering were judged to be more severe on higher weighted words than lower weighted words. The author concluded that, in agreement with Brown's (1945) hypothesis, increases in frequency and severity of stuttering are due to the increased demands of producing more meaningful words.

Bloodstein (2001) believed that children who stutter (CWS) have difficulties with syntactic encoding. He suggested that early stuttering exhibited by children and more developed stuttering exhibited by adults represented two different disorders (Bloodstein, 1997; Bloodstein, 2001). He observed that when children are disfluent, they have difficulties with initiating an utterance. This observation corresponds with Brown's (1945) report that children tend to stutter at the start of an utterance and the types of stutters are whole word repetitions and phrase repetitions. Children initially do not have difficulty with production of a particular word. Rather, they have difficulties formulating entire utterances. Many children outgrow these difficulties and they become fluent. Other children persist in their stuttering due to their attitude and beliefs. They anticipate that they are going to stutter, which led to Bloodstein's (1997) proposal of an "anticipatory struggle hypothesis". Because older children anticipate they are going to stutter, the pattern of stuttering changes. Production of single words becomes the problem rather than the formulation of a whole utterance. According to Bloodstein (1997), this is a learned behaviour and to change this behaviour, people have to change their beliefs.

Bernstein Ratner (1997) described different aspects of language which may influence the fluency of an utterance, such as phonetic, phonological, lexical and syntactical factors. She suggested that it is challenging to study these factors individually because they influence each other. For example, phonemes that occur most often in word initial position are stuttered less frequently than phonemes that occur less often at the start of a word, which indicates there are phonetic constraints to moments of stuttering. However certain words are used more

frequently in spoken language than others and therefore it may not just be the type of phoneme contributing to stuttering moments but the entire word (i.e., lexical influences). Bernstein (1997) describes two types of lexical factors contributing to stuttering, (1) word frequency and (2) word class. Word frequency refers to the frequency with which a word occurs in a language, while word class refers to specific types/categories of words (e.g., nouns, verbs). Finally, syntactic constraints are also assumed to play a role because both normal disfluencies and stuttering occur more often at the start of long and complex sentences. Bernstein (1981) and Wagovich and Berstein Ratner (2007) found that children stuttered frequently on complex grammatical structures. The children stuttered often at the start of a sentence and within a sentence at the start of a verb phrase. She explained that moments of stuttering were likely due to processing demands of stringing words together into a syntactically correct phrase.

Postma and Kolk (1993) proposed the Covert Repair Hypothesis (CRH) to describe moments of stuttering. The authors suggested that disfluencies occur due to difficulties with phonological encoding. The authors describe the covert repair cycle during the process of speech production as (a) detection of an error by an internal monitoring system, (b) interruption of speech production, (c) revision of the phonetic plan and (d) execution of this plan. Specifically, errors in phonological encoding are detected by an internal monitoring process. When the errors are repaired successfully (internally), the subsequent speech will be produced fluently. That is, there is a covert repair which results in overt fluent speech. According to Postma and Kolk (1993), PWS are slow in phonological decoding which results in disfluencies. PWS have difficulties with generating the phonetic plan in time, resulting in a moment of stuttering. According to the CRH, the type of disfluency depends on how many phonemes were spoken when the error was detected and the speech interrupted. Disfluencies occur in fluent and disfluent speakers, however speakers who are regarded as fluent tend to

use phrase repetitions, whole word repetitions and silent pauses, all caused by semantic, syntactic and lexical errors.

van Lieshout, Starkweather, and Hulstijn (1995) acknowledged the influence of various lexical factors on stuttering – among others, word size, word position and sentence length. van Lieshout et al. proposed that lexical factors directly influence stuttering by making demands on the motor system for speech. They studied the speech of 12 adults without stuttering and found that articulatory effort, as measured electromyographically, increased for initial words and longer words. For sentence length, an increase in rate and decrease in muscle activity was observed. The authors considered how these findings could be applied to the stuttering population. They described PWS as having a more variable speech motor system and suggested that, if they respond to the above lexical factors similarly to people without stuttering (namely, by increasing articulatory effort), that the chances of stuttering under these conditions increase.

Howell (2004) and colleagues (Howell & Au Yeung, 2002; Howell, Au-Yeung & Sackin, 2000) proposed the EXPLAN theory in regard to stuttering behaviour. The EXPLAN theory considers both motor and linguistic factors as being important for fluent speech. The EXPLAN theory specifies that during speech there is continuous planning and execution of sounds, syllables and words. A linguistic formulator has to PLAN the words, and the motor programmer has to EXECUTE this plan. During continuous speech, the plan for the next word is being generated while the previous word is being produced. As long as the plan is ready before the next word is spoken, there will be fluent speech. Sometimes, the plan is not ready in time, which will result in moments of speech disfluency. The speaker can deal with this problem in two different ways. For example, in the phrase *"the castle"*, if the linguistic planning for the word "*castle"* is incomplete, the speaker would gain time by repeating the previous word until the plan is ready, e.g. *the the the castle*. This type of disfluency is

referred to as "stalling". The second way to deal with the problem is to begin producing the word while the entire planning for this word is incomplete, e.g. *ca ca castle.* This type of disfluency is referred to as "advancing". Words that are phonologically more complex are assumed to be more difficult to plan and require more planning time (Howell et al., 2000). Howell (2004) states that linguistic context plays an important role in speech planning. For example, when there are several short words (i.e., few phonemes) before a complex word (i.e., more phonemes), it is likely that the plan for this longer word would be incomplete because the shorter words have a brief execution time. When people exhibit stalling in their speech, the type of disfluency is likely to be either a whole word or phrase repetition because the plan for these words was complete (i.e., it is the ensuing word that has an incomplete plan). When people exhibit advancing, only a part of the plan for that particular word is complete, and therefore the disfluency is likely to be a sound/syllable initial repetition or prolongation.

Content and Function Words

Content words refer to a class of words that includes nouns, main verbs, adverbs and adjectives. Function words are a word class that consists of auxillary verbs, pronouns, articles, prepositions and conjunctions (Hartmann & Stork, 1972). Content words belong to an open lexical class because new words are added to this class over time (e.g., twitter, iPod). Furthermore, content words carry the stress and semantic meaning in an utterance (Leow, Campos, & Lardiere, 2009). Function words belong to a closed lexical class because no new words are added to this category. They carry the grammatical function in an utterance and they are less stressed than content words (Brown, 1945; Leow et al., 2009). Function words also tend to be comprised of fewer phonemes and syllables compared to content words. According to Levelt (1992), content words are stored in a different mental lexicon than function words which may have an influence on the retrieval of these words.

A variety of studies have looked at moments of stuttering associated with the production of content words and function words. A common finding in past research is that CWS tend to stutter more often on function words whereas AWS are found to stutter more often on content words (Bernstein, 1981; Bernstein Ratner, 1997; Au-Yeung, Gomez, & Howell, 2003; Dayalu, Kalinowski, Stuart, Holbert, & Rastatter, 2002; Dworzynski, Howell, & Natke, 2003; Juste, Sassi, and de Andrade, (2012); Howell, Au-Yeung, & Sackin, 1999). The precise reason for the content-function word dichotomy has been debated. For example Dayalu et al. (2002) suggest that the content-function word dichotomy noted between CWS and AWS can be explained on the basis of a generalized adaptation hypothesis. Stuttering adaptation is a phenomenon, whereby a reduction in stuttering occurs as a result of repeated production of the same word or phrase (Neelley & Timmons, 1967). According to the generalized adaptation hypothesis, the frequent occurrence of function words in English initially poses a challenge to CWS, resulting in high levels of stuttering on these words. However, it is the frequent occurrence of function words that eventually leads to a reduction of stuttering on these word types due to an adaptation effect. As the CWS eventually becomes the AWS, there is a shift in stuttering to words that occur less often in the English language (i.e., content words). Thus, the breakdown in the retrieval, formulation, and eventual speech production in AWS is explained by the lack of familiarity or regular use of content words.

Bernstein (1981) and others (Rispoli & Hadley, 2001; Rispoli, 2003) suggest a link between a child's acquisition of morpho-syntax and speech fluency. It is not unusual for normally developing children to produce disfluencies early in their language development. These disfluencies tend to occur in longer and more grammatically complex utterances compared to fluent utterances (Rispoli & Hadley, 2001). This finding accounts for differences in the readiness to assemble certain sentence components according to experience and development of the syntactic system over time. Consequently, children will stutter less on

function words as their syntactic system develops and certain sentence components can be assembled more quickly. Interestingly, Bernstein emphasises that function words belong to the syntax plan and are not to be analyzed on a lexical level.

Perhaps the most elaborate explanation regarding the nature of stuttering on content and function word comes from the EXPLAN theory proposed by Howell and Au-Yeung (2002). The theory has identified specific rules regarding the nature of stuttering that occurs on content and functions words in AWS. Howell et al. (1999) suggested that the more complex syllable structure of content words may impose greater demands on the speech motor system during the planning and production of speech. Thus, the more frequent occurrence of stuttering on function words in CWS is thought to reflect a "stalling" tactic. Because function words often occur immediately prior to content words, the child is thought to stutter on the phonetically easier word (i.e., function word) so as to gain additional time to plan for production of the subsequent phonetically more complex word (i.e., the ensuing content word). As children mature, they change the way in which they respond to content words. They abandon the stalling tactic via function words, and instead, shift this stalling tactic to the phoneme-initial or syllable-initial form of the adjacent content word. This theory also predicts that stuttering on function words will typically only occur at the region of a function/content word boundary. This is because function words are usually short words which are executed rapidly. Content words tend to be longer words which require greater planning time. When one (or several) short function words occur before a content word, there is not always sufficient time for the planning of the content word. Therefore the stutter will occur on a function word in this particular context. Furthermore the type of stutter exhibited on a function word will be a whole-word repetition. In this context, the AWS is exhibiting a stalling technique. The primary support for this pattern of content and function word stuttering comes from Au-Yeung, Howell and Pilgrim (1998) who found significantly more

stuttering on function words occurring before a content words compared to function words after a content word. However, it is important to note that the AWS sample comprising the Au-Yeung et al, study consisted of only 12 adults. The EXPLAN account of the pattern of stuttering related to content and function words is intriguing. Yet, it would seem necessary to validate these findings using a considerably larger sample size of AWS.

Word Frequency

Another linguistic factor which can influence speech fluency is word frequency. Research has shown that words which occur more frequently in the language tend to be produced more fluently by PWS (Anderson, 2007; Dell, 1990; Soderberg, 1966; Hubbard & Prins, 1994). Some of the earliest research in this area dates back to Soderberg (1966) who investigated whether word frequency and word length were independent factors that could influence the frequency of stuttering. Twelve PWS, aged 12 – 44 years were required to read aloud 90 words, which varied in word length and word frequency. There were three types of word length (short, medium, long) and three types of word frequency (low, medium, high). All words were content words, had the same word-initial phoneme, and had stress placed on the first syllable. Results showed there was significantly more stuttering on words occurring less frequently and on longer words. Word length appeared to be a stronger contributing factor to moments of stuttering in compared to word frequency. Significant differences in the amount of stuttering was found across all three word lengths, while significant differences were only apparent between words of low and high frequency. These results were interpreted to indicate that word length and word frequency are independent variables influencing the frequency of stuttering.

More recently, Anderson (2007) looked at the linguistic variables of word frequency, neighbourhood frequency and neighbourhood density, and their influence on moments of stuttering. Neighbourhood density was described as the number of words that differ in

phonetic structure from another word based on a single phoneme. For example, the words *sit*, *fit* and *it* have a close neighbourhood density as a result of differing by only one phoneme. Neighbourhood frequency was defined as the frequency of the target word's neighbour. Anderson collected language samples from 15 children who stuttered between the ages of 3 to 5 years and found that the stuttered words were significantly lower in word frequency, as well as in neighbourhood frequency, compared to their control words. Furthermore, Anderson examined whether word frequency had an influence on the type of disfluencies. Single syllable word repetitions, part word repetitions and sound prolongations were included and all other disfluencies were excluded. Results showed that part word repetitions and sound prolongations occurred on words with a lower word frequency than their control words. This difference was not found for whole word repetitions. When looking at neighbourhood frequency, results showed that part word repetitions occurred significantly more often in words that were lower in neighbourhood frequency compared to their control words. No significant differences were found for single syllable repetitions and sound prolongations. Neighbourhood density did not have an effect on the frequency nor on the type of disfluencies.

It is important to note that the results for Anderson (2007) were based on a sample size of only 15 CWS and the results for Soderberg (1966) were based on a sample of 12 AWS. A larger sample size of PWS seems warranted to validate whether a feature such as word frequency is indeed discriminating of stuttering behaviour.

EXPLAN and Word Frequency

Interestingly, Howell (2010) and Anderson (2010) have recently debated whether the results of the Anderson (2007) study provide further support for the EXPLAN theory. According to Howell (2010), the finding by Anderson (2007) of sound repetitions and prolongations on words of low frequency confirms the assumptions of the EXPLAN theory.

These particular types of stuttering are reflective of "advancing" stuttering behaviours and would be predicted to occur on words of high complexity. Presumably, low frequency words are more complex than high frequency words because of their less-frequent occurrence in the language. According to Anderson (2010), the results of her earlier study neither support nor refute the EXPLAN theory because the study was never originally intended to test this theory. Rather, the original purpose of the study was to further describe the speech production processes of CWS. According to Anderson, a direct test of the EXPLAN theory would involve examining word frequency of (non)stuttered content and function words. If Howell's (2010) assertions are correct, it would be predicted that the word frequency of stuttered content words would be lower than non-stuttered (control) content words, because stuttered content words are rarer (i.e., more complex). Furthermore, there should be no difference in the word frequency of stuttered function words compared to non-stuttered (control) function words, because the breakdown in fluency that occurs for stuttered function words is a reflection of the adjacent (complex) content word. To date, a comparison of the word frequency of content and function words has not been performed.

Statement of the Problem

The influence of word type and word frequency on moments of stuttering has been a popular area of research for several years. The EXPLAN theory has been developed in regard to the specific pattern of stuttering associated with the production of content and function words (Howell & Au-Yeung, 2002). Examination of word frequency would suggest that moments of stuttering are most likely to occur on words that occur less often in the language (Anderson, 2007). Both of these findings are based on research examining small groups of individuals who stutter. Furthermore, a drawback of past studies is that these various features have been examined in isolation. To validate the results of past studies and further define the speech production processes of AWS, it would be worthwhile to examine these features collectively using a large participant sample. The purpose of this study was to explore stuttering behaviour associated with word-type and word-frequency in a large group of AWS. The following hypotheses were posed:

Hypothesis 1: A moment of stuttering will occur most often on content words compared to function words.

Hypothesis 2: Moments of stuttering on a function word will occur at the function/content word boundary.

Hypothesis 3: Word frequency will be lower for stuttered words compared to non-stuttered words.

Hypothesis 4: Syllable repetitions will occur more often on function word compared to content words.

Hypothesis 5: Word frequency for stuttered content words will be higher compared to non-stuttered (control) content words.

Hypothesis 6: Word frequency for stuttered function words and non-stuttered (control) function words will be similar.

Method

Participants

Fifty AWS (6 females, 54 males) were recruited for participation in the study. The participants ranged in age between 18 and 62 years (M = 33 years, SD = 12). The sex, age and stuttering severity of the participants was not controlled for in the present study. The participants were attending a one-week stuttering intensive treatment programme at the University of Utah (Salt Lake City, USA). On the first day of this programme, a reading sample and a conversational speech sample were obtained from each participant. These samples were used as a baseline of stuttering behaviour. The data used for the present study were based on the conversational speech samples.

Data Collection

The number of words comprising the conversational samples collected for the participants ranged from 87 to 736 and averaged 360 words (SD = 154.0). The topics of conversation were not held constant, although the topics generally included recently watched movies, holiday destinations and life experiences. Each of these samples was audio recorded. The conversational samples were orthographically transcribed and disfluencies were noted on the transcriptions. The types of disfluencies identified included syllable repetitions, initial sound repetitions, multi-syllable repetitions and blocks (audible & inaudible). The percentage of words stuttered ranged from 2% to 52% and averaged 15% (SD = 12.8%) for the group.

Data Analysis

Content and function words. Based on examination of the orthographic transcripts, the distribution of stuttering on content words and function words was analysed. Function words included auxiliary verbs, pronouns, articles, prepositions and conjunctions. Content words included nouns, main verbs, adjectives and adverbs. Words that could be both a function and

a content word depending on the lexical context were included in the analysis. For example if the primary verb *to be* functioned as auxillary verb (*I was born in England)* it was analyzed as a function word and if it acted as a main verb *(I was there)* it was analyzed as content word. The procedures used for identification of content and function words were similar to those used by Schäfer and Robb (2012).

Function/content word boundary. The determination of the function/content word boundary was based on noting a moment of stuttering on a function word. If the stuttered function word immediately preceded a content word, the stutter was judged to occur at the function/content word boundary. Occasionally, there were instances when several function words occurred immediately preceding a content word. For example in the phrase "*..on the train…"* both *on* and *the* are function words. If the stutter occurred on the word *the*, this was analyzed as being at the function/content word boundary. If the stutter occurred on the word *on*, this was analyzed as not being at the function/content word boundary. The total number of stuttered function words that occurred at the function/content word boundary was tabulated for each participant, as well as for the group.

Word frequency. The determination of word frequency followed the general procedures of Anderson (2007). Each instance of a stuttered word was submitted to an online database (WordCount.org) of approximately 87,000 words. The database provided a numeric value for each word. Words that occurred often in the English language were given a low numeric value. For example the word "the" is the most frequently used word in the English language and is given a value of 1, while the word 'autocrat" has a ranking of 80,000. The word frequency of each stuttered word was first determined, followed by identifying the corresponding control word. Control words were obtained by matching a stuttered word with a non-stuttered word that occurred later in the speech sample. This was often in the same utterance but sometimes this occurred in a later utterance. The control word needed to be of

the same grammatical class (content word or function word) and with the same number of syllables. If either the stuttered word or its control word did not exist in the database, they were both excluded from the analysis. In the case of contractions, (such as *I'm*), word frequency was based on the first word of the contraction (in this case *I)*. The control word was the first word (in this case the first function word) that was fully and fluently pronounced (Anderson, 2007).

Results

Stuttering on content and function words

The results for percentage of stuttering in content and function words are listed in Table 1 and displayed in Figure 1. Across the 50 participants, the percentage of stuttering on content words ranged from 0% to 95% and averaged 60.6 % (SD = 20.4%) for the group. The percentage of stuttering on function words ranged from 5% to 100% and averaged 32.6% (SD = 16.3%) for the group. Across the 50 participants, 36 participants showed a higher percentage of stuttering on content words than on function words. Results from a paired *t*-test conducted on the occurrence rate of stuttering revealed significantly more stuttering on content words compared to function words ($t(49) = 5.48$, $p < 0.001$).

Additional analysis of the data was performed as a function of the frequency of stuttering. A median split of the data was undertaken to separate the participants into subgroups of high versus low percentage of stuttering. Accordingly, 25 participants were placed into each subgroup. The percentage of stuttering on content and function words was then reanalyzed according to the subgroups. A two-way (2 word types X 2 groups) analysis of variance (ANOVA) was conducted. The within-groups factor was word type (content or function) and the between-groups factor was stuttering subgroup (low or high frequency of stuttering). Results of the analysis identified a significant word-type effect [$F(1, 48) = 29.54$, $p < 0.001$]. There was no significant group effect [$F(1, 48) = 0.04$, $p = 0.83$] or group-by-word type interaction effect [$F(1, 48) = 0.10$, $p = 0.746$] (see Figure 2). The results of the ANOVA confirmed a significant difference in stuttering between content and function words; however there was no significant association between stuttering severity group and word type.

Table 1. Distribution of the percentage of stuttering on content and function words. In some instances the combined percentage occurrence on content and function words did not sum to 100%. This was due to phrase repetitions which were not included in totals for content or function words.

Participant	Amount of words stuttered	% content words	% function words
1	42	36%	50%
2	45	51%	49%
3	141	82%	18%
4	33	73%	18%
5	23	87%	13%
6	75	65%	29%
7	22	73%	27%
8	21	62%	38%
9	22	95%	5%
10	116	66%	31%
11	90	84%	13%
12	35	60%	37%
13	95	34%	45%
14	9	56%	33%
15	72	75%	22%
16	7	71%	29%
17	14	21%	57%
18	29	41%	45%
19	38	68%	29%
20	21	57%	29%
21	31	58%	23%
22	46	33%	48%
23	23	35%	35%
24	16	63%	25%
25	44	77%	18%
26	54	39%	48%
27	21	81%	19%
28	27	85%	11%
29	18	78%	22%
30	15	67%	27%
31	41	37%	44%
32	38	61%	34%
33	22	82%	18%
34	27	78%	19%
35	31	68%	29%

36	8	38%	50%
37	9	67%	33%
38	19	32%	53%
39	42	69%	31%
40	78	41%	56%
41	35	86%	11%
42	19	26%	42%
43	76	75%	24%
44	71	75%	25%
45	58	74%	22%
46	48	44%	56%
47	5	0%	100%
48	29	76%	24%
49	101	63%	31%
50	110	66%	33%

Figure 1. Group percentage of stuttering on content words versus function words. The corresponding standard deviation is shown.

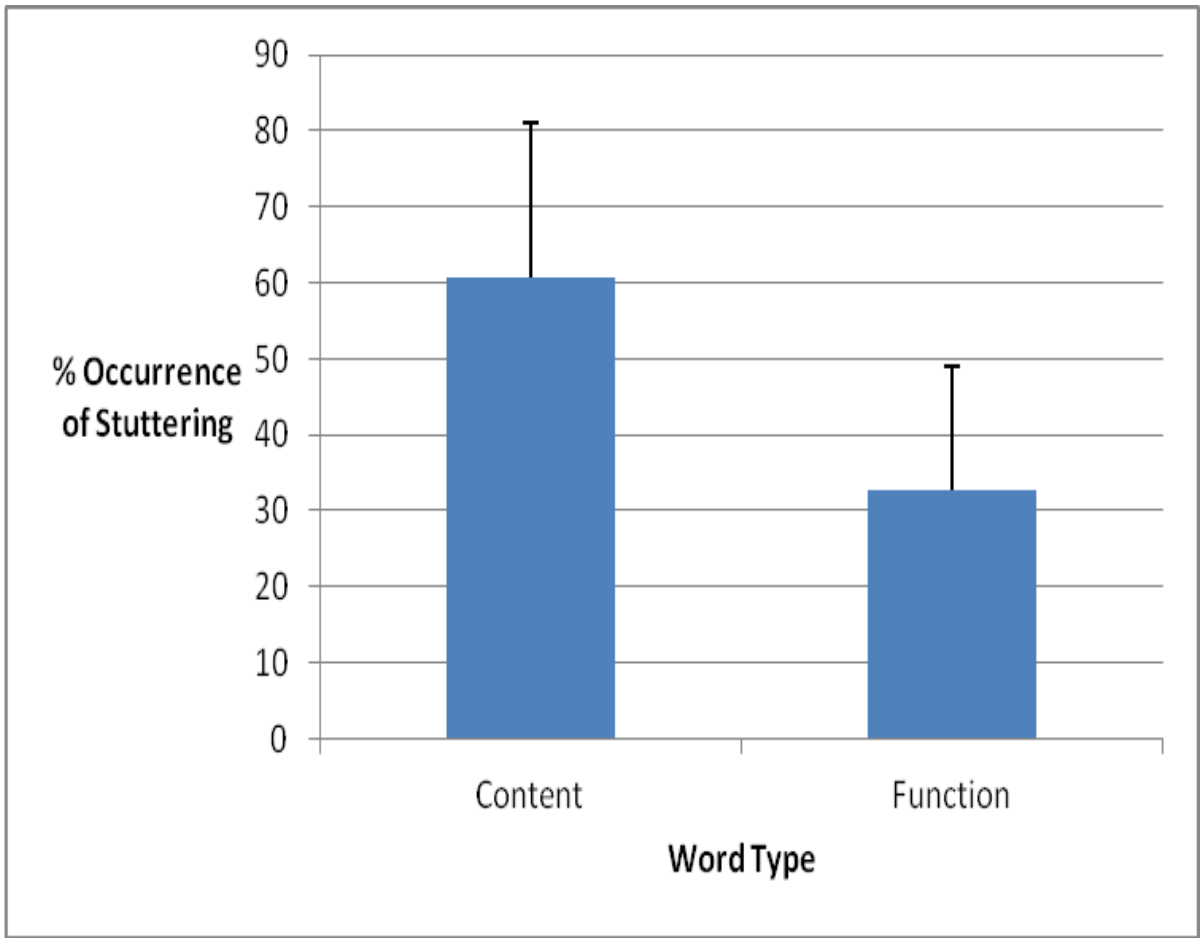
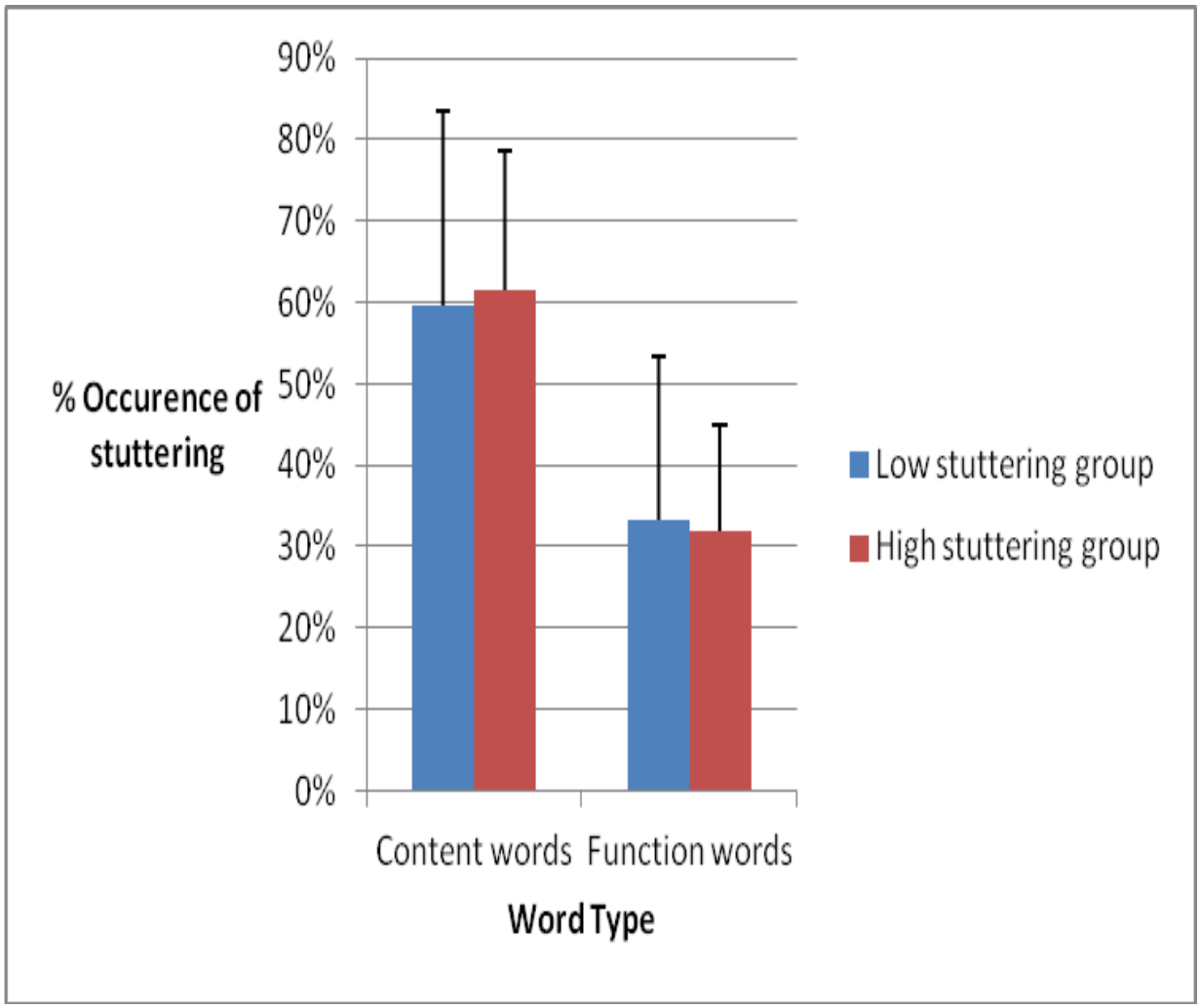


Figure 2. Group percentage of stuttering on content words versus function words according to participants' frequency of overall stuttering. The corresponding standard deviation is shown.



Stuttering at the function/content word boundary

Results for the analysis of moments of stuttering of function words at the function/content word boundary are listed in Table 2. Across the 50 participants, the percentage of function words that were stuttered at the function/content word boundary ranged from 38% to 100% and averaged 72.7% (SD = 17.4%) for the group. A paired *t*-test was performed to assess whether the occurrence rate of stuttering on function words at the function/content word boundary was significantly higher compared to the non-boundary position. The test was significant ($t(49) = 9.207$, $p < 0.001$). A display of the results is presented in Figure 3.

These same data were reanalyzed as a function of overall frequency of stuttering, using the subgroups of low and high frequency of stuttering (i.e., median split). Results for the low stuttering group revealed that 72.4% (118 out of 163) (SD = 19.9%) of the stuttered function words occurred at the function/content word boundary. For the high stuttering group 65.5% (324 out of 495) (SD = 12.9%) of the stuttered function words occurred at the function/content word boundary. A chi-square test was performed to assess whether the occurrence rate of stuttering on function words at the function/content word boundary differed between the subgroups. No significant association between group and word position was found ($\chi^2 = 2.67$, $p = 0.102$), indicating that a participant's overall frequency of stuttering did not influence the pattern of stuttering on function words.

Table 2. Distribution of function words that were stuttered at the function/content (F/C) word boundary.

Participant	Amount of Function Words	F/C boundary instances	% Stuttered function words at the FC word boundary
1	21	14	67
2	22	19	86
3	26	17	65
4	6	5	83
5	3	3	100
6	22	14	64
7	6	6	100
8	8	5	63
9	1	1	100
10	36	19	53
11	12	7	58
12	13	9	69
13	43	28	65
14	3	3	100
15	16	7	44
16	2	1	50
17	8	6	75
18	13	6	46
19	11	10	91
20	6	3	50
21	7	6	86
22	22	15	68
23	8	6	75
24	4	4	100
25	8	6	75
26	26	16	62
27	4	3	75
28	3	2	67
29	4	3	75
30	4	3	75
31	18	11	61
32	13	10	77
33	4	2	50
34	5	4	80
35	9	7	78
36	4	3	75
37	3	3	100

38	10	6	60
39	13	12	92
40	44	24	55
41	4	4	100
42	8	3	38
43	18	10	56
44	18	10	56
45	13	8	62
46	27	20	74
47	5	5	100
48	7	7	100
49	31	20	65
50	36	26	72

Figure 3. Group percentage of function words stuttered at the function/content word boundary. The corresponding standard deviation is shown.

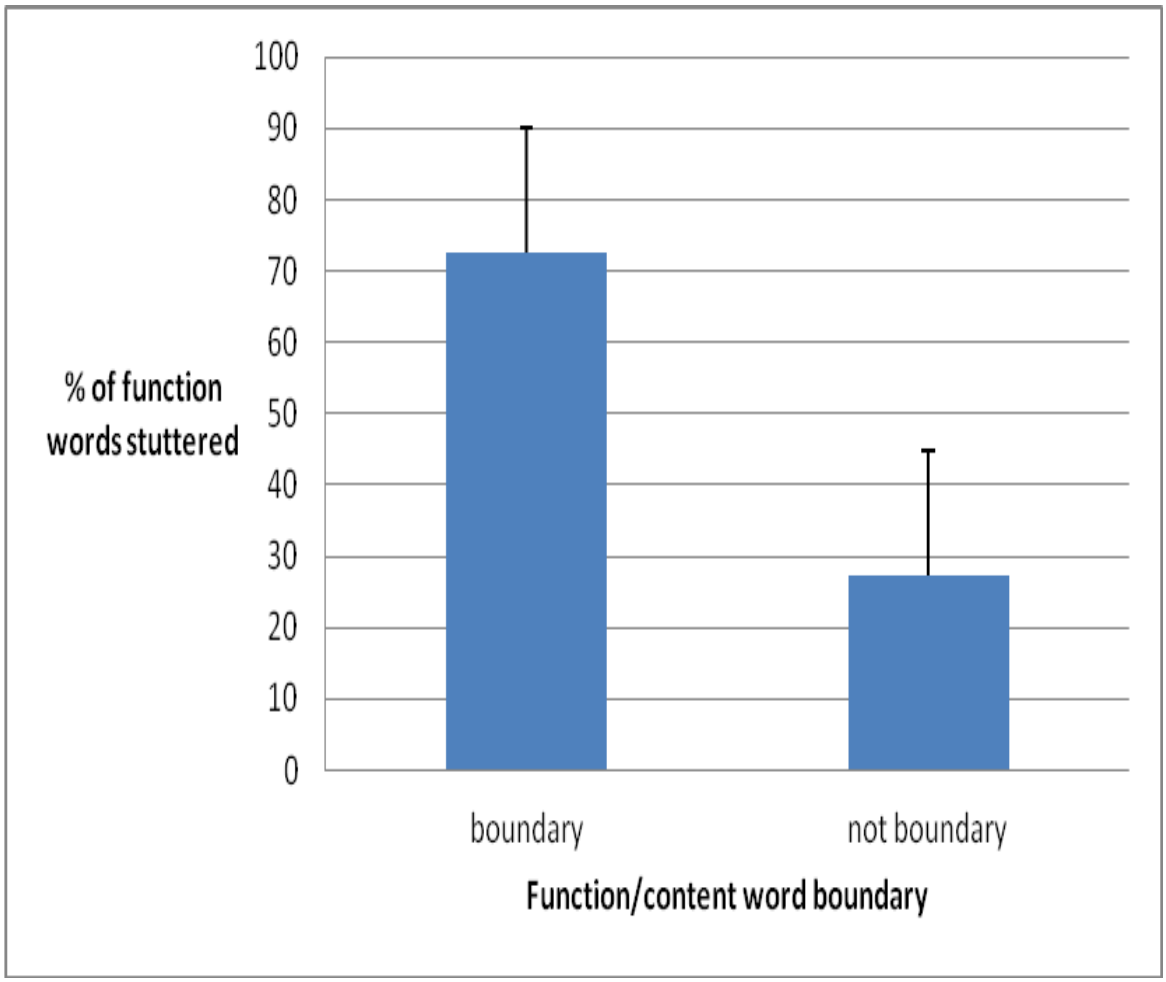
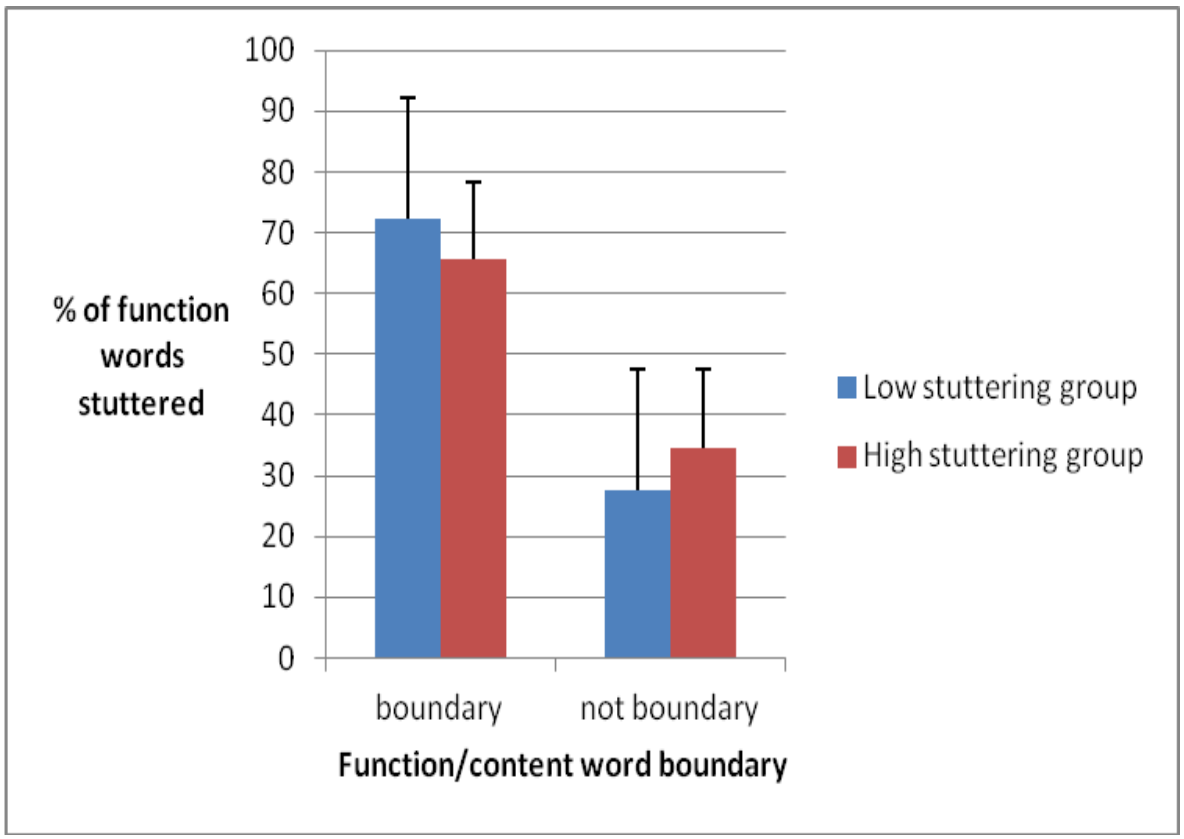


Figure 4. Percentage of function words stuttered at the function/content word boundary according to subgroups of low and high overall stuttering. The corresponding standard deviation is shown.



Word frequency

Recall that a word frequency of a low value reflects a word that occurs more often in spoken language. The average word frequency ranking for stuttered words ranged from 28 to 8038 and averaged 2803.4 (SD = 2125) for the group. The average word frequency ranking for control words ranged from 10 to 8030 and averaged 2142.5 (SD = 1776) for the group. The results for the word frequency analysis are listed in Table 3 and displayed in Figure 5. A Wilcoxon signed ranks test was performed to determine whether the word frequency rank of stuttered words differed from the word frequency ranking of control words. The test was significant (Z = -2.138, $p = 0.033$), indicating a significantly lower word frequency rating for control words compared to stuttered words. That is, control words were found to occur more often in the spoken language.

The data were further explored with respect to overall frequency of stuttering by performing a median split. In the low stuttering percentage group, the average word frequency ranking for stuttered words was 2539.1(SD = 2473) and the average word frequency ranking for control words was 1933.4 (SD = 1589). The word frequency rankings were slightly higher in the high stuttering percentage group. The word frequency ranking for stuttered words was 3067.7 (SD = 1720) and the average word frequency ranking for control words was 2351.7 (SD = 1956). These results are displayed in Figure 6. A two-way (2 word categories X 2 groups) ANOVA was conducted. The within-groups factor was word category (stuttered word & control word) and the between groups factor was stuttering subgroup (low and high frequency of stuttering). The word frequency ranking scores showed a significant word category effect [$F(1, 48) = 4.276$, $p = 0.044$] but no significant group effect [$F(1, 48) = 1.086$, $p = 0.303$] or group-by-word type interaction effect [$F(1, 48) = 0.03$, $p = 0.864$]. Results of the ANOVA confirmed a significant difference in word frequency

between stuttered and control words; however there appeared to be no influence with regard to participants' overall percentage of stuttering.

Results of the analysis of word frequency according to stuttered and non-stuttered (control) content and function words are provided in Table 4. Across the 50 participants, the average word frequency for stuttered content words ranged from 221 to 9335 and averaged 4298 (SD = 2784) for the group. The control content words ranged from 210 to 12,339 and averaged 3611 (SD = 3099) for the group. A paired t-test was performed to see if the word frequency differed between stuttered and control content words. The test was not significant [$t(49) = 1.28$, $p = 0.20$]. The word frequency of stuttered function words ranged from 6 to 121 and averaged 32 (SD = 28) for the group. The word frequency of control function words ranged from 3 to 626 and averaged 49 (SD = 103) for the group. Similar to the results for content words, there was no statistically significant difference in the word frequency of stuttered and control function words [$t(49) = 1.14$, $p = 0.25$].

Table 3. Distribution of the mean (M) word frequency rankings of stuttered words (combined content & function words) and the corresponding control words. Note: low frequency values indicate a more frequent/often occurrence in the spoken language.

Participant	*M* word frequency of stuttered words	*M* word frequency of control words
1	1187	891
2	1154	687
3	2735	170
4	1126	1955
5	8038	1927
6	3449	3747
7	672	565
8	1357	2388
9	6151	5434
10	2161	1017
11	1963	1806
12	1115	1328
13	1723	1846
14	671	1471
15	3806	1394
16	1340	990
17	196	1150
18	1130	5392
19	2458	228
20	1432	555
21	4155	425
22	2832	2287
23	472	289
24	6541	1208
25	3862	1870
26	3066	3148
27	7275	2609
28	4822	1077
29	2202	203
30	1475	4510
31	3476	619
32	2030	1541
33	5025	6393
34	4528	3885
35	5873	4568
36	142	669
37	1706	1564
38	3380	4496
39	1868	2119

40	1263	2227
41	6722	3969
42	974	699
43	2776	8030
44	4577	2567
45	6290	2663
46	373	3886
47	28	10
48	1765	1734
49	6124	2637
50	684	284

Figure 5. Group average word frequency ranking of stuttered words versus control words. The corresponding standard deviation is shown. Note: low frequency values indicate a more frequent/often occurrence in the spoken language.

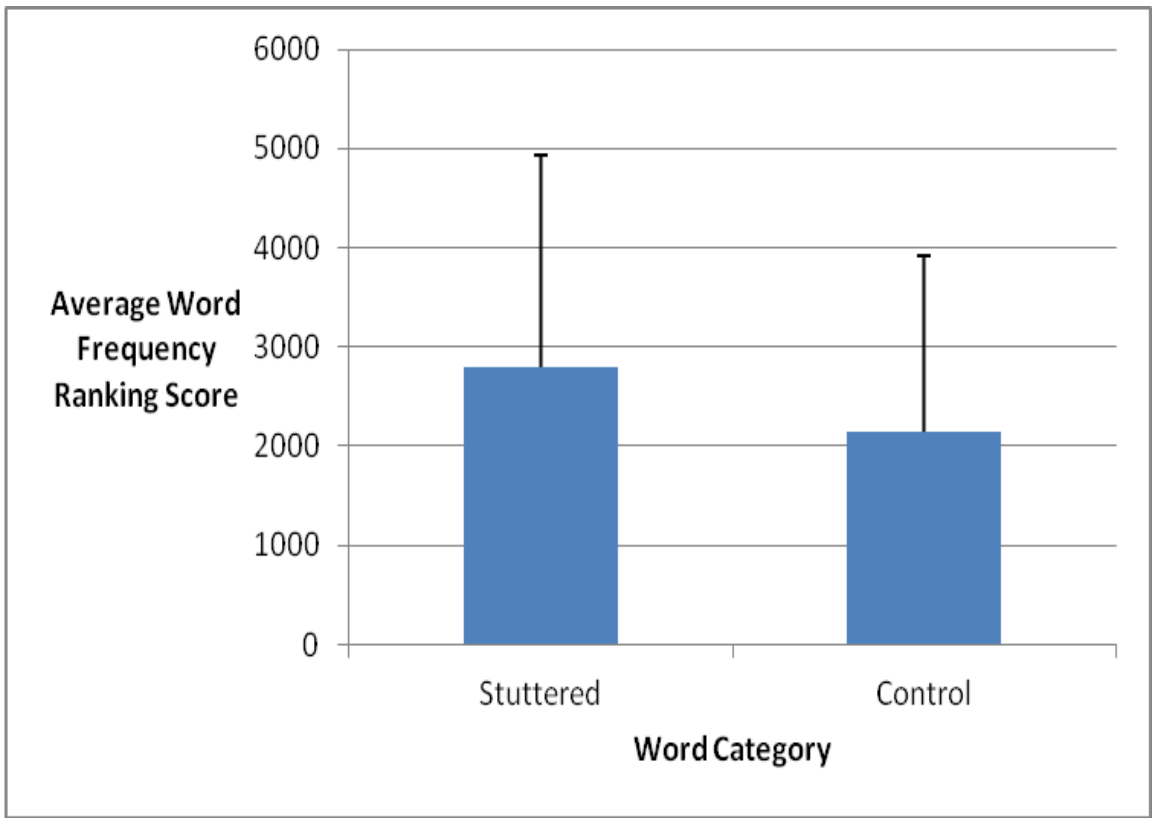


Figure 6. Average word frequency ranking of stuttered words versus control words according to subgroups of overall percentage of stuttering. The corresponding standard deviation is shown. Note: low frequency values indicate a more frequent/often occurrence in the spoken language.

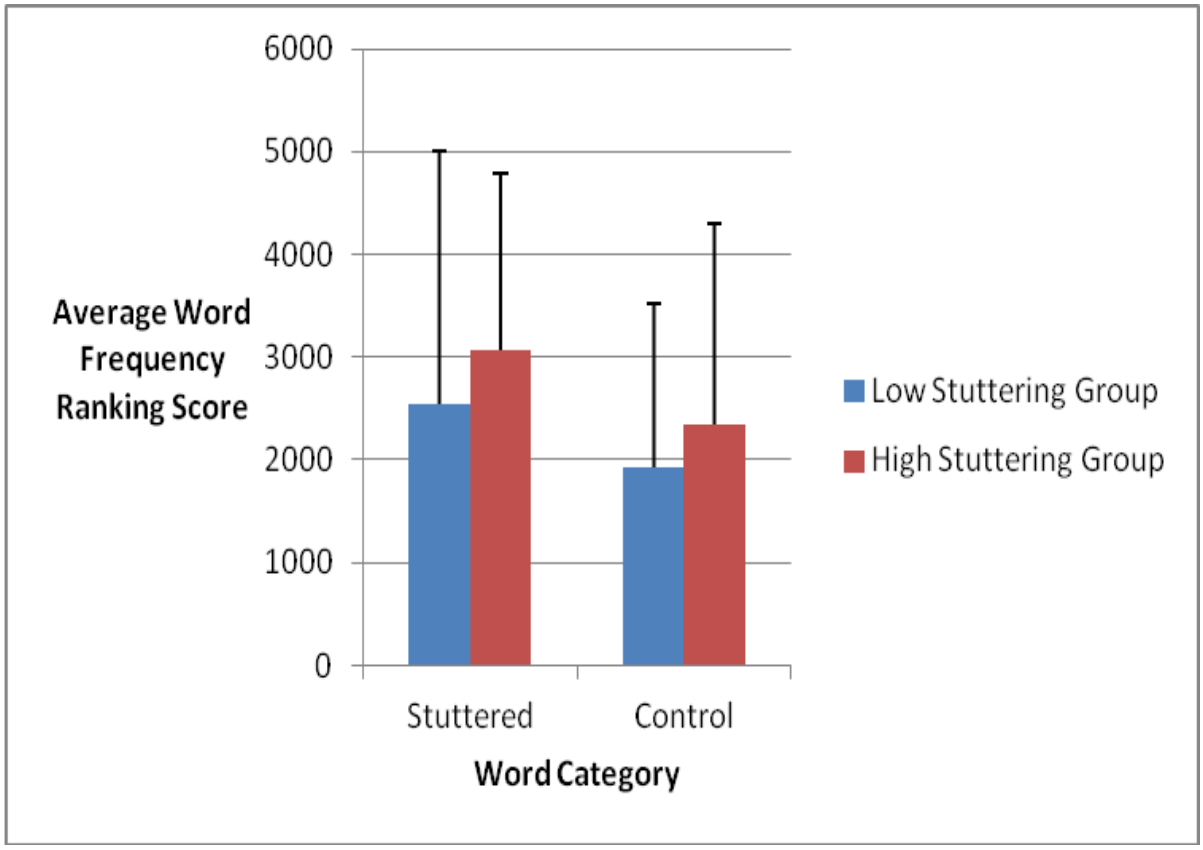


Table 4. Distribution of the mean (M) word frequency rankings of stuttered and non-stuttered (control) content and function words.

Participant	M word frequency stuttered content words	M word frequency control content words	M word frequency stuttered function words	M word frequency control function words
1	2819	2255	21	21
2	2392	1244	29	9
3	3471	210	46	18
4	1460	2539	13	8
5	9303	2354	26	4
6	5054	5489	19	25
7	886	739	116	112
8	2248	3949	21	48
9	6475	5719	11	12
10	3280	1518	17	16
11	2271	2087	16	27
12	1807	2172	104	95
13	3954	4352	23	41
14	1064	2349	16	9
15	5011	1832	40	27
16	1858	1378	48	21
17	695	4194	9	8
18	2434	12339	51	49
19	4022	363	41	18
20	2194	843	36	28
21	5833	591	79	21
22	7254	5849	17	20
23	1088	615	9	46
24	9787	1793	48	39
25	4791	2313	30	41
26	7023	6611	22	249
27	8985	3222	8	3
28	5509	1228	8	21
29	2994	269	22	22
30	2306	7081	22	12
31	7614	1338	29	20
32	3325	2488	121	11
33	6458	8213	6	25
34	5855	5022	16	19
35	9168	7129	15	16

36	221	1502	83	44
37	2724	2492	9	27
38	8983	11965	17	15
39	2728	3098	14	12
40	2978	5243	16	33
41	7714	4555	29	13
42	2478	817	33	626
43	3660	10602	28	28
44	6411	3612	93	13
45	8269	3500	50	24
46	1015	10932	16	376
47	N/A		28	10
48	2327	2505	13	29
49	9335	4012	13	22
50	1116	441	18	41

Syllable repetitions

Across the 50 participants, the percentage of syllable repetitions on content words ranged from 0% to 100% and averaged 12.9 % (SD = 18.4%) for the group. The percentage of syllable repetitions on function words ranged from 0% to 100% and averaged 51.3 % (SD = 30.9%). To evaluate whether the occurrence of content and function word syllable repetitions differed, a paired *t*-test was performed. The test was significant [$t(49) = 9.81$, $p < 0.001$), indicating more syllable repetitions occurring on function words compared to content words. The results are presented in Table 5 and displayed in Figure 7.

The data were further explored with respect to subgroups of overall stuttering (low vs high). The results of this analysis are shown in Figure 8. A two-way ANOVA was performed. The within-groups factor was word type (syllable repetition of function words & syllable repetition of content words) and the between groups factor was stuttering subgroup (low and high frequency). The test was significant for word type [$F(1, 48) = 96.93$, $p < 0.001$], indicating a higher percentage of syllable repetitions for function words compared to content words. There was no significant word type-by-group interaction [$F(1, 48) = 1.30$, $p = 0.25$]. but there was a significant group effect [$F(1, 48) = 4.587$, $p = 0.037$]. The low stuttering percentage group had a mean occurrence of 38.3% (SD = 33.9%) for syllable repetitions (combined content and function words), which was significantly higher than the high frequency stuttering group. This group had a mean occurrence of 25.8% (SD = 28.5%) for syllable repetitions (combined content and function words).

Table 5. Distribution of syllable repetitions in content and function words.

Participant	Amount of content words	% of syllable repetitions on content words	Amount of function words	% of syllable repetitions on function words
1	15	33	21	38
2	23	4	22	23
3	115	3	26	23
4	24	13	6	83
5	20	10	3	33
6	49	8	22	27
7	16	6	6	83
8	13	8	8	50
9	21	9	1	100
10	76	29	36	89
11	76	1	12	58
12	21	19	13	77
13	32	44	43	72
14	5	40	3	67
15	54	2	16	56
16	5	20	2	50
17	3	100	8	88
18	12	25	13	92
19	26	4	11	0
20	12	42	6	83
21	18	17	7	86
22	15	20	22	95
23	8	38	8	63
24	10	0	4	0
25	34	0	8	75
26	21	38	26	85
27	17	0	4	25
28	23	4	3	33
29	14	7	4	75
30	10	20	4	0
31	15	0	18	56
32	23	4	13	77
33	18	6	4	50
34	21	0	5	20
35	21	0	9	22
36	3	33	4	75
37	6	0	3	67
38	6	0	10	80
39	29	3	13	8

40	32	3	44	23
41	30	0	4	0
42	5	20	8	100
43	57	0	18	50
44	53	0	18	6
45	43	2	13	38
46	21	0	27	11
47	0	0	5	60
48	22	9	7	57
49	64	0	31	26
50	73	0	36	8

Figure 7. Group mean and standard deviations of the percentage of occurrence of syllable repetitions across content and function words.

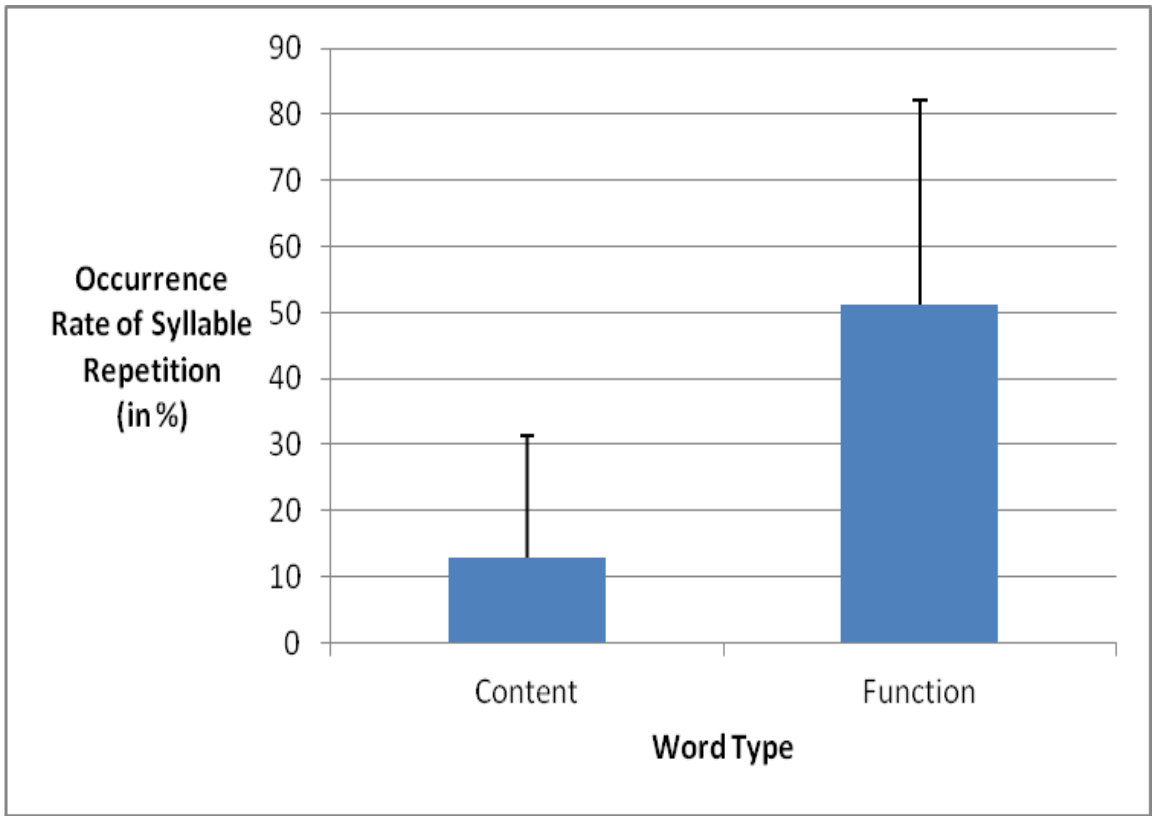
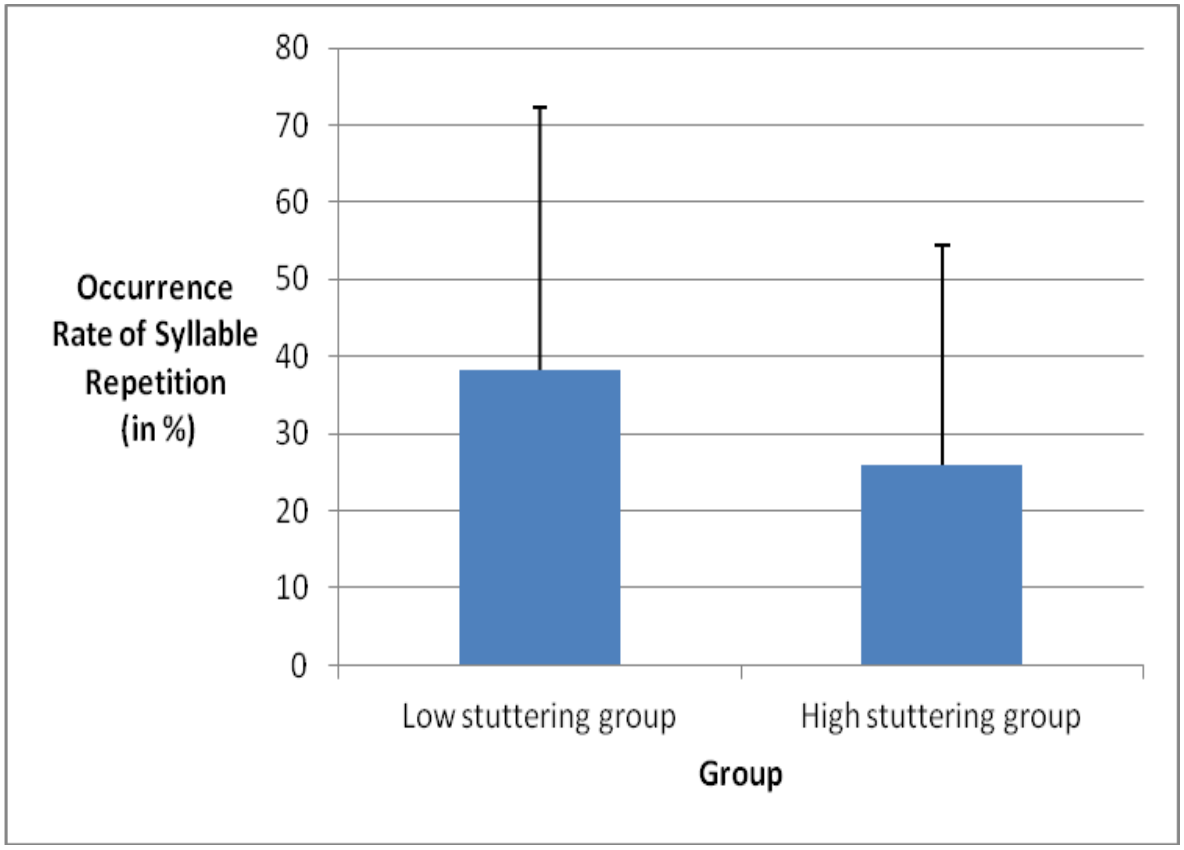


Figure 8. Mean and standard deviations of the percentage of occurrence of syllable repetitions (combined content and function words) according to the two subgroups of stuttering frequency.



Summary of Results

1. Results revealed significantly more stuttering on content words compared to function words.

2. The occurrence of stuttering on function words at the function/content word boundary was significantly higher compared to the non-boundary position.

3. Stuttered words, as compared to the control words, showed a significantly higher word frequency ranking, indicating a less frequent occurrence of these words in spoken language.

4. Function words, as compared to content words, showed a significantly higher mean percentage of occurrence of syllable repetitions.

5. Following performing a median split with respect to the overall frequency of stuttering, results suggested that the low stuttering group had a larger overall occurrence of syllable repetitions than the high stuttering group.

6. There were no significant differences in the word frequency of stuttered and non-stuttered content words.

7. There were no significant differences in the word frequency of stuttered and non-stuttered function words

Discussion

Hypothesis 1: A moment of stuttering will occur most often on content words compared to function words.

The results of statistical testing revealed significantly more stuttering on content words compared to function words for the entire group. A similar pattern was found when examining the participants according to subgroups of stuttering frequency. Based on these combined results, hypothesis 1 is accepted. The present findings are in agreement with several past studies that have found more stuttering on content words (Dayalu et al., 2002; Dworzynski et al., 2003; Juste et al., 2012). Several interpretations for the higher stuttering on content words compared to function words have been proposed. Howell's EXPLAN theory (Howell & Au-Yeung, 2002) proposes that disfluencies occur when the planning of a word is not ready in time for speech execution. Planning of phonologically complex words takes longer than planning for simple words. The present study did not specifically examine the phonological complexity of words; however content words are known to be more phonologically complex than function words. According to EXPLAN, when children who stutter do not have enough time to plan a content word, they tend to repeat the function word that occurs immediately prior to the (neighbouring) content word to gain time. Howell refers to this process as "stalling" as a means to gain time for the eventual speech execution of more complex content words. In the early teenage years this strategy is abandoned and PWS start to produce the content word when the plan is not ready, which results in a part-word repetition of the content word (Howell et al., 1999; Au-Yeung et al., 2003).

An alternative interpretation of stuttering on function and content words was provided by Dayalu et al. (2002). These researchers attributed the pattern of stuttering on content and function words to stuttering adaptation. Function words occur in the spoken language more frequently than content words and therefore this type of word is easier to access, process and

articulate than content words. According to Dayalu et al., this leads to a generalised adaptation effect rather than transitory adaptation effect. Transitory adaptation occurs when PWS read a passage several times and subsequently adapt to the words in the passage, as indicated by a decrease in frequency of stuttering (Johnson & Inness, 1939). However this type of adaptation disappears after several hours. Adaptation to function words is more permanent because function words are used frequently in everyday conversational situations. The authors pose that this generalised adaptation effect leads to less stuttering on function words.

In spite of the generally observed pattern of frequent stuttering on content words, there are still unanswered questions. One such question relates to the observation that many participants in the present study were fluent and disfluent on the same words. For example one of the participants used the word "family" four times but stuttered on this word only twice. This suggests that there must be other factors contributing to stuttering than simple lexicon. In the current study, moments of stuttering were examined at the word level and not at the clause level. Bernstein (1981) suggested that syntactic structures play an important role in moments of stuttering. Bernstein found that both fluent and disfluent young children tend to be disfluent at the start of a grammatical unit. They were most often disfluent at the start of a sentence and at a conjunction point. A difference found by Bernstein was that the disfluent group stuttered more often on the verb phrase compared to the fluent group. However, the many similarities between the two groups point to difficulty of planning at the clause level rather than the word level. Therefore, when people are disfluent, it may not be the planning of a specific word but the planning of a clause that disrupts the flow of speech. Further research is necessary to explore other factors such as utterance position as previously researched by Au-Yeung, Howel and Prilgrim (1998). These authors looked at utterance position of disfluent content words and function words. Function words at the start of an utterance were

disfluent significantly more often than function words in other positions of the utterance. Content words did not show a significant position effect.

Hypothesis 2: Moments of stuttering on a function word will occur at the function/content word boundary.

The results of statistical testing revealed that when stuttering occurred on a function word, this happened significantly more often at the function/content word boundary compared to the function/function word boundary. This pattern was found for the overall group of PWS, as well as according to subgroups of low and high frequency of stuttering. Accordingly, hypothesis 2 is accepted. According to the EXPLAN theory (Howell & Au-Yeung, 2002; Howell, 2004), disfluencies arise when there is insufficient time to plan for the pronunciation of a word. Howell (2004) suggests this planning difficulty occurs in the production of content words. EXPLAN proposes that when a function word is stuttered, it is most likely to occur in the environment of a function/content word boundary. In the current study, 72.7% of the function words were stuttered at the function/content word boundary. These results differ from Au-Yeung's study (1998), who found that more than 90% of the disfluent function words occurred before a content word. A possible reason for the differences observed between studies is to consider the analysis methods. Au-Yeung used *phonological words* for the analysis of stuttering pattern. A phonological word was defined as a content word and any number of function words that serve as prefix or affix. The reason for using phonological words was to provide a method of classifying function words as either a pre-content or post-content function word. In a phonological word, there may be several function words before a content word, all of which would be considered in the analysis of stuttering pattern. In the case of the utterance "*After work I will drive to the shop",* the verb "will" is a function word. If a participant stutters on the word "I" it would not be at the function/content word boundary, however it would be before the content word in a

phonological word because *"I will drive"* is a phonological word. Therefore in Au-Yeung's study, a higher percentage of disfluent function words would be judged to occur at the function/content word boundary compared to the present study. It is likely that the percentage of function/content word instances in the current study would have been higher if the Au-Yeung method had been used.

In the present study, nine out of the 50 participants showed that when they stuttered on a function word, it was at the function/content word boundary 100% of the time. However for 11 participants the amount of stuttering on function words at the function/content word boundary was less than 50%. The percentage of stuttering on function words (at the function/content word boundary) for these 11 participants varied from 4% to 43%. On the basis of these results it would seem that the influence of a function/content word boundary on stuttering behaviour is not consistent across PWS.

A large proportion of the stuttered function words identified in the analysis were conjunctions, prepositions and pronouns. There was no specific pattern which explained stuttering on the type of function words that occurred at the function/function word boundary. For example, one participant was frequently disfluent on prepositions such as *"on the person, in his race* and *into the United States".* Another participant frequently stuttered on conjunctions and started many sentences with a conjunction word such as "*And I, And they, But I"* and stuttered on the first word. Some participants produced long utterances and were disfluent on the conjunction words, a pattern which is often seen in children who stutter (Bernstein, 1981). In the present study, there appeared to be no particular type of function word category more vulnerable to stuttering.

Further research seems necessary to examine the sentence structure characteristics of PWS. For example, is the general sentence structure of PWS at the function/content word

boundary similar to the sentence structure of CWS? Furthermore, is it possible to predict when a stalling-type disfluency is likely to occur in a PWS?

Hypothesis 3: Word frequency will be lower for stuttered words compared to non- stuttered words.

The results of statistical testing revealed that stuttered words had a significantly lower word frequency in the English language compared to the control words for the overall group of PWS. A similar pattern was found when the groups were subdivided according to the frequency of stuttering. Therefore hypothesis 3 is accepted.

Previous research has shown that word frequency has an effect on the frequency of stuttering in both children (Anderson, 2007) and adults (Soderberg, 1966; Hubbard & Prins, 1994). Hubbard and Prins found that PWS stuttered significantly more on words occurring less often in the English language when reading aloud sentences. Soderberg found similar results when PWS (aged 12 – 44 years) had to read aloud words in isolation. All the words had the same initial sound and the stress was on the first syllable. Anderson examined the word frequency in young CWS engaged in conversational speech. She found that stuttered words occurred significantly less often in the language compared to the frequency of control words. Anderson applied a rather elaborate criterion for the selection of control words in her study compared to the present study. The control words in Anderson's study were matched (to the corresponding stuttered word) according to the number of syllables and phonemes, as well as grammatical class. The control words in the current study matched only in grammatical class and number of syllables. In spite of these differences the present results align with those of Anderson.

Are these results compatible with the EXPLAN theory? According to Howell (2010), words which occur less frequently are more likely to involve an increase in planning time and therefore become more susceptible to stuttering. The results of the current study revealed that

as a group, stuttered words occur less often in the English language compared to control words. However this was not the case for 17 of the 50 participants. On average, the words they stuttered upon occurred more frequently in the English language compared to the control words. Of these 17 participants, eight participants stuttered more on function words than on content words. The remaining nine participants stuttered more on content words and therefore the percentage of function words stuttered is not a likely explanation for the higher stuttering rate on words occurring more frequently in the English language. In addition, the overall frequency of stuttering in these 17 participants varied between 2% and 44%, which indicates that the overall amount of stuttering cannot explain the pattern of stuttering on words that occur often or infrequent in the English language.

It is important to consider possible confusion between word frequency and word familiarity when performing an analysis of word type. Word familiarity refers to whether a certain word is contained in an individual's vocabulary/lexicon. Word frequency refers to how often a word occurs in a certain language. Hubbard (1994) found that when PWS were required to read aloud sentences, they stuttered more often on sentences containing words that were not familiar to them. The current study focused on word frequency; however the participants talked about a topic that was familiar to them. For example, one participant used the word "*basketball"* several times during their conversational speech. This word was produced fluently and was used as a control word several times. Interestingly, the word "*basketball"* does not occur often in the English language, yet this word was highly familiar to that person. Clearly, it seems that instances such as this, where there is high word familiarity but low word frequency can have an influence on the fluency of a PWS. Further research seems necessary to differentiate the influence of word frequency and word familiarity on stuttering.

Another factor to consider for future research is the word frequency of content words following a stuttered function word. The current study looked at the word frequency of all stuttered words (combined function and content) and their corresponding control words. According to EXPLAN (Howell & Au-Yeung, 2002; Howell, 2004), PWS are likely to encounter difficulties in the production of content words even when they stutter on a function word. When they stutter on a function word, the plan for the content word is not ready and they are presumably stalling to gain time. In line with this theory, it would be interesting to determine the word frequency of the content word following the stuttered function word and perform a separate analysis.

Although there were no group differences identified according to frequency of stuttering, it is of interest to note that the high stuttering group exhibited higher word frequency scores compared to the low stuttering group. This finding would suggest that a higher rate of stuttering may be associated with word choice. There is a lack of research exhibiting the actual word choices made by PWS. This may be a fruitful area of research.

Hypothesis 4: Syllable repetitions will occur more often on function word compared to content words.

Results revealed that the occurrence of syllable repetitions was significantly higher on function words compared to content words and therefore hypothesis four is accepted. These results are compatible with the EXPLAN theory (Howell & Au-Yeung, 2002; Howell, 2004). According to EXPLAN, people are disfluent when the plan of a content word is not ready for execution. As such, disfluency can either occur at the onset of the content word or in the preceding word, which is usually a function word. Howell suggests that disfluencies occurring on function words tend to be whole word repetitions. Because function words are often one syllable words, the type of stuttering will likely be a syllable repetition. According

to Howell, this pattern of stuttering occurs mainly in children and also in people who are regarded as normally fluent. The second possibility is that people will be disfluent on a content word and this disfluency occurs when only a part of that word is ready to be executed. If the plan is not ready before the beginning of that word is articulated, this will result in a sound repetition, a sound prolongation or blocking. This second possibility occurs in people who display persistent stuttering.

When looking at the two subgroups of PWS, results showed that the low stuttering subgroup had a higher occurrence of syllable repetitions than the high stuttering subgroup. This finding is interesting but not surprising. Early stuttering is characterised by mainly whole word and syllable repetitions. This behaviour can also be observed in people who are regarded as normally fluent. This suggests that the people in the low stuttering subgroup showed similar behaviours as normally fluent adults, as well as CWS. It seems that stuttering severity (as inferred by the percentage of stuttering) may play a role in regard to the type of stutter shown in content and function words. Yet, the actual moment of stuttering seems to be linked to lexical or syntactical factors.

The finding of primarily syllable repetitions in the low frequency stuttering group compared to the high frequency stuttering group (as well as different word frequency rankings) provides support for the notion of subgroups of PWS. Past research has looked at subgroups of PWS based on etiology, reaction to drugs, biological characteristics, concomitant disorders, developmental course and prominent features (Yairi, 2007; 2011). Prominent features of stuttering include severity levels and type of disfluencies. Some researchers have differentiated between "tonic" and "clonic" stuttering (Froeschels, 1943; Feinberg, Griffen & Levey, 2000). Froeschels described "tonic" stuttering as characterised by prolongations and blocks, and is caused by pressure on the speech muscles. The author posed that "clonic" stuttering was characterised by repetitions and was due to linguistic

difficulties. Feinberg et al. (2000), found differences in personality and cognition between "tonic" and "clonic" adults who were stuttering. The people in the "tonic" subgroup were more aware of their stuttering occurrences. Furthermore, they had lower thought disorder scores and a higher verbal IQ than the people in the "clonic" sub-group. Schwartz and Conture (1988) described subgroups in young CWS. The authors looked at both speech and non-speech behaviours and found five different subgroups. However the authors suggested these could be reduced to two subgroups if they would primarily consider the type of the disfluency; namely one subgroup with children who predominantly produced repetitions and the other subgroup who predominantly produced prolongations. These two subgroups seem to support the "tonic" and "clonic" sub-groups described by Froeschels (1943). Results of the current study showed that although the low frequency stuttering group and the high frequency stuttering group did not differ in the previous hypothesis related to moments of stuttering and word frequency, they differed in regard to stuttering type. There was also an observed difference (albeit non significant) in the word frequency of stuttered words used by the low and high frequency stuttering groups. Therefore the results for this particular hypothesis lend support to the notion of subgroups of PWS on the basis of stuttering type, not on moments of stuttering.

Hypothesis 5: Word frequency for stuttered content words will be higher compared to non-stuttered (control) content words.

Hypothesis 6: Word frequency for stuttered function words and non-stuttered (control) function words will be similar.

These hypotheses were originally posed based on the previous debate between Howell (2010) and Anderson (2010). Howell suggested that the results of an earlier study by Anderson (2007), which examined word frequency of stuttered and non-stuttered words, were supportive of the EXPLAN theory. Specifically, Anderson (2007) found that the types of

stuttering that occurred on words of low frequency were primarily sound repetitions and prolongations. According to EXPLAN, these represent "advancing" type stutters that occur primarily on complex words. Howell (2010) proposed that complex words are also low frequency words and thus the stuttering behaviour exhibited on these words fit with the EXPLAN theory. However, in order for these earlier data to fit with EXPLAN, it would also be necessary to show that the low frequency (i.e., complex) words were stuttered content words.

This proposal was tested in the current study by specifically examining word frequency of stuttered and non-stuttered content and function words. Results of the analyses found no statistically significant differences in the word frequency of stuttered and non-stuttered (control) content and function words, respectively. Therefore, Hypothesis 5 is rejected but Hypothesis 6 is accepted. It is interesting to note that the average word frequency of stuttered content words (M = 4298) was indeed higher than the average word frequency of control content words (3611). Further, it is important to note that for four of the participants, their average control content word frequencies were in excess of 10,000; whereas no such values were found for the stuttered content words. It is likely these extreme values further inflated the overall group average for control content words, thereby contributing to the lack of a significant difference. So while the statistical testing of stuttering and control contents words was indicative of no difference, the general pattern observed for both content words and function words would appear to support Howell's (2010) contention of the rather intricate relationship between word complexity, word frequency and word type.

Limitations

There are some limitations to the present study that need to be considered. Firstly, the speech samples analyzed in the present study were provided to the researcher by another

(overseas) laboratory. Therefore, there was no opportunity to directly observe and interact with the participants. It is possible that a better understanding of the stuttering behaviours exhibited by the participants would have been obtained if the researcher had directly collected the samples. Although the researcher did not have firsthand experience interacting with the PWS, the reliability of these samples was ensured by the laboratory that provided the samples.

Secondly, no phonological words were used when determining whether moments of stuttering on a function word occurred at the function/content word boundary. In order to validate Howell's EXPLAN theory (Howell, 2002; 2004) more thoroughly, it would have been beneficial to use Au-Yeung's (1998) approach of using phonological words. Au-Yeung found a higher number of stuttering on function/content word boundary instances compared to the current study. Although an increase in function/content word boundary instances could be predicted by looking more closely at the function words before a content word, this was not statistically confirmed.

Lastly, the current analysis did not look closely at outliers and it may be that these outliers provide valuable information. For example, looking at hypothesis one, 36 of the 50 participants showed a higher percentage of stuttering on content words than on function words. Why did the other 14 participants stutter more frequently on function words? Did these participants have more difficulty with formulating language and syntactic structures similar to children who are acquiring a language (Bernstein 1981)? Is it possible that these participants had difficulties with retrieving words (Levelt, 1992)? Or did these participants use content words that were phonetically simple content words which were easier to plan (Howell, 2000)? In regard to word frequency, results showed that for 33 participants, the word frequency for stuttered words was lower compared to non-stuttered words. It is possible that the other 17 participants used many words that were familiar to them but had an overall

low frequency in the English language. Another possibility would be to compare the outliers of the four different hypotheses of this study. Did these participants show different results for one or more of the above hypotheses? If they did show different results for several of the above questions, this could possibly shed further light on subgroups of PWS.

Directions for Future Research

The results of the present study seem to provide evidence for the existence of subtypes of PWS. For example, people in the low stuttering group, exhibited more syllable repetitions than the people in the high stuttering group. People in the low stuttering group also stuttered on words that occurred more frequently in the language compared to the people in the high stuttering group. Yairi (2011) reported that there is insufficient research conducted on subtypes of stuttering. Future research could determine if there are particular subtypes of stuttering that can be differentiated on factors such as anxiety ratings, language abilities or personality (Feinberg et al, 2000; Yairi, 2007). Furthermore it would be interesting to determine if non-speech stuttering behaviours are associated with different stuttering types (Schwartz and Conture, 1988). The combination of these different dimensions may lead to a subgroup classification system, which may lead to different treatment options (Yairi, 2007).

The current study considered the relationship between moments of stuttering and the word frequency of stuttered (and control) words. Another approach to consider would be in the evaluation of stuttering and word familiarity. Hubbard (1994) found PWS stuttered more often on words that were unfamiliar to them. It would be challenging to examine features such as word familiarity in conversational language samples; however it would be possible to provide participants with compulsory words to use in a narrative. This would allow using words highly familiar and highly unfamiliar to the participants.

Previous work examining word frequency determined the word frequency of the stuttered word and compared this with a control word. A further study could be designed that examines the principle of "stalling" as explained in the EXPLAN theory (Howell, 2002; 2004). According to EXPLAN, PWS have problems with content words even when they stutter on a neighbouring function word. When they stutter on a function word, the plan for the content word is not ready and they are stalling to gain time. In line with this theory, it would be interesting to determine the word frequency of the content word following the stuttered function word and compare that with the word frequency of the control word. Presumably, the content word would be a word that occurs less often than the function word.

While the analysis undertaken in the present study was based on simple analysis of the EXPLAN theory in regard to content and function words, there is research that has considered the influence of phonetic complexity on moments of stuttering (Howell, Au-Yeung & Sackin, 2000; Howell, Au-Yeung, Yaruss & Eldridge, 2006). According to EXPLAN, phonologically complex words need more planning time and therefore they are more likely to be stuttered. Different methods have been used to determine the phonetic complexity of a word. Howell et al. (2006) used the Index of Phonetic Complexity (IPC) developed by Jakielski (1998) to determine the phonetic difficulty of a word. This scheme uses a variety of articulatory factors such as place, manner, words shape, words length and consonant clusters. The authors found that stuttered content words of teenagers and adults had a higher IPC score compared to non-stuttered content words. Factors having most influence on disfluency were consonants by manner, consonants by place, word length and consonant clusters. Phonetic complexity could not be researched in this study because orthographic rather than phonetic transcriptions served as the data base.

Finally, the current study examined features of stuttering that occur at the word level. Although the results of this analysis were informative, it is important to recognize that

stuttering is a dynamic process and occurs as part of connected speech. Accordingly, domains such as sentence structure characteristics of PWS (Bernstein, 1981) and utterance position of disfluent content words and function words (Au-Yeng., et al., 1998) could be examined.

Summary

In summary, this study showed that moments of stuttering occur more often on content words than on function words. If stuttering occurred on a function word, this occurred most often on the function/content words boundary. Syllable repetitions occurred more often on function words compared to content words. Furthermore, when the participants were divided in two groups relating to the frequency of stuttering, the people in the low stuttering group showed more syllable repetitions compared to the high stuttering group. Word frequency for stuttered words (function words & content words combined) was lower than for non-stuttered words; however when analysed in respect to function and content words there was no significant difference. In general, the EXPLAN theory proposed by Howell et al. (2004) is supported by the present results.

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